Surface compositional heterogeneity on Mercury inferred from MESSENGER spectral measurements

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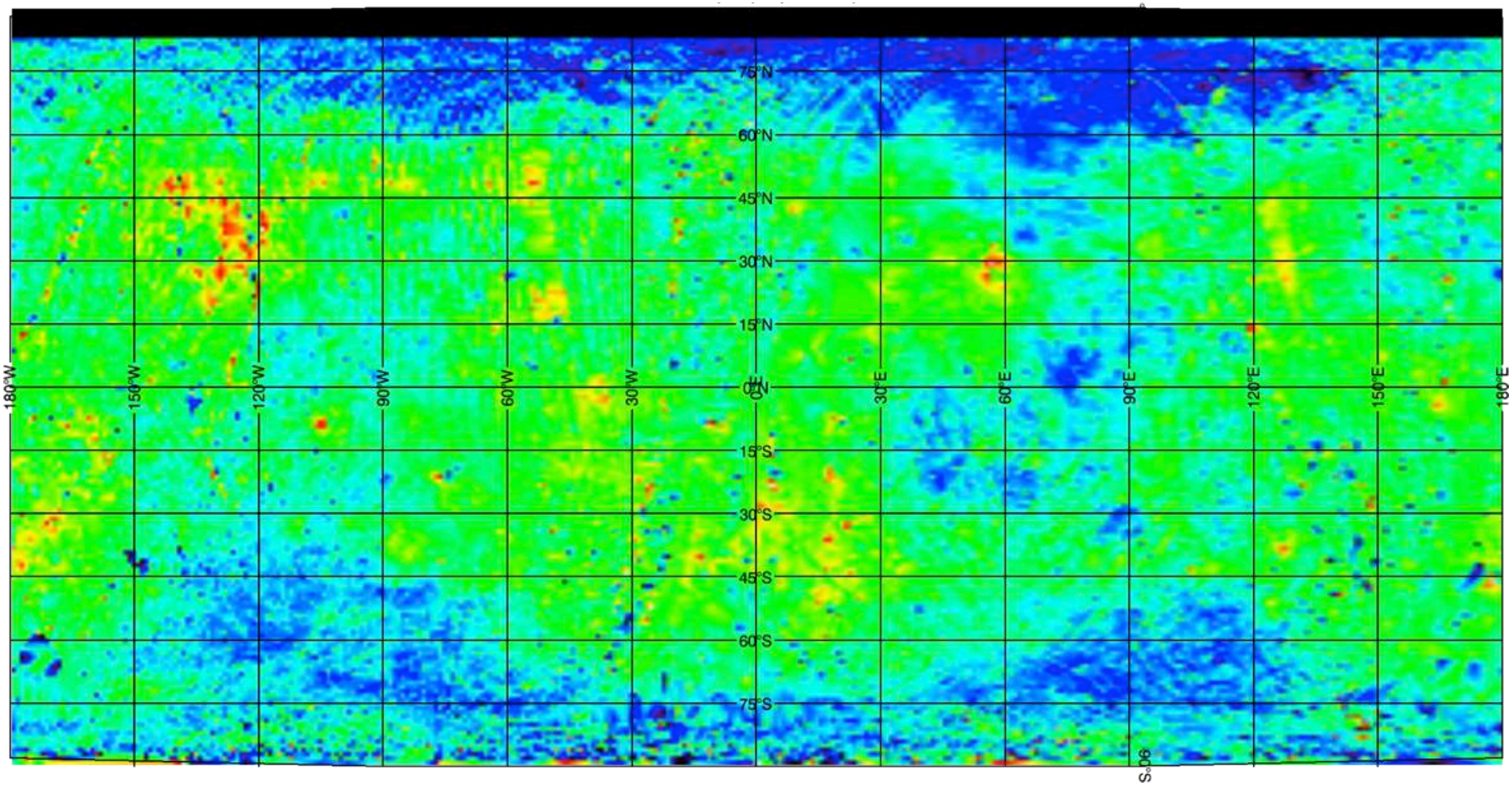
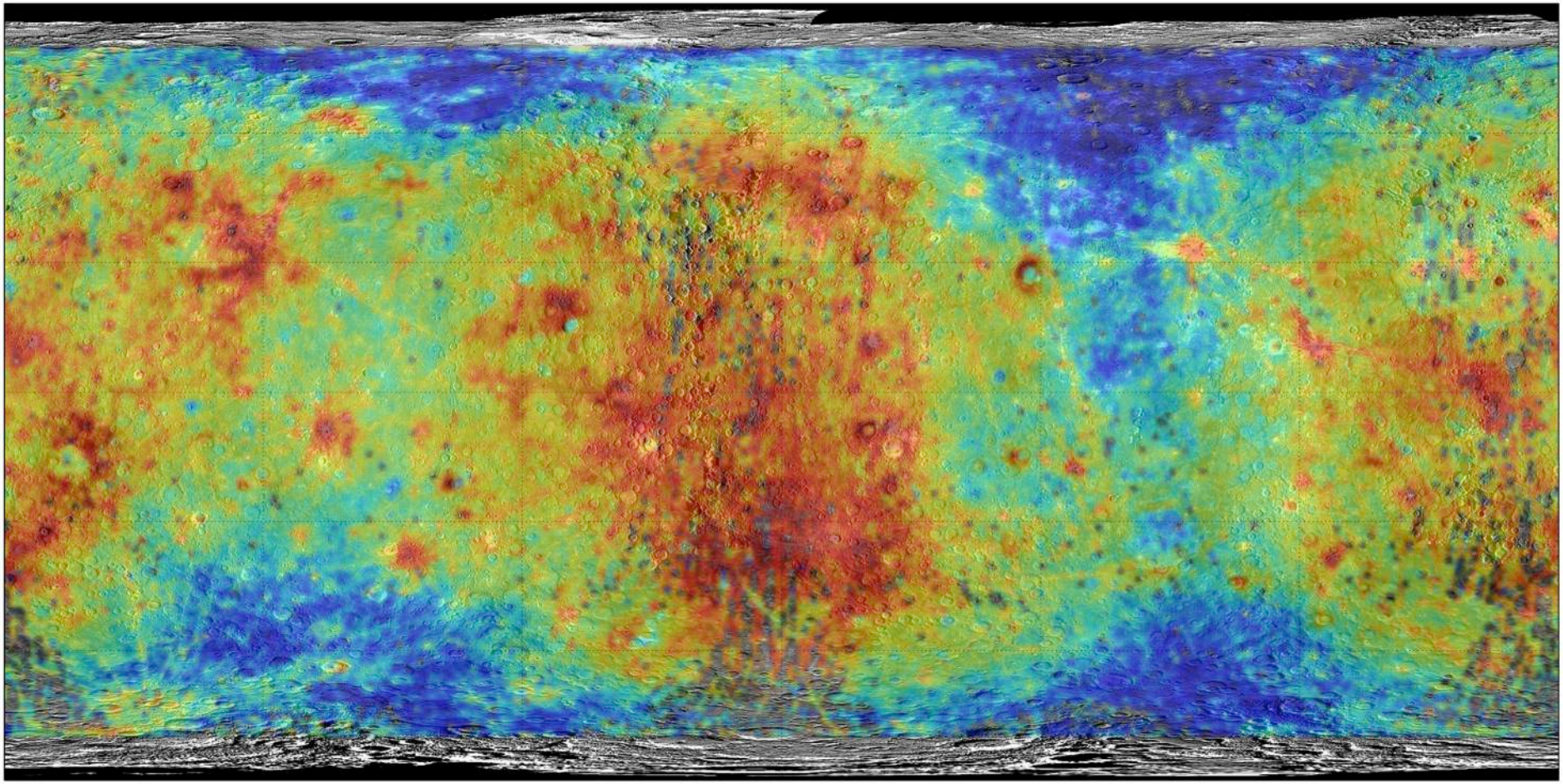
PEL Planetary Emissivity Laboratory DLR

Reflectance(345-355 nm)/Reflectance(700-750 nm) **1x1** degrees grid



MASCS Data

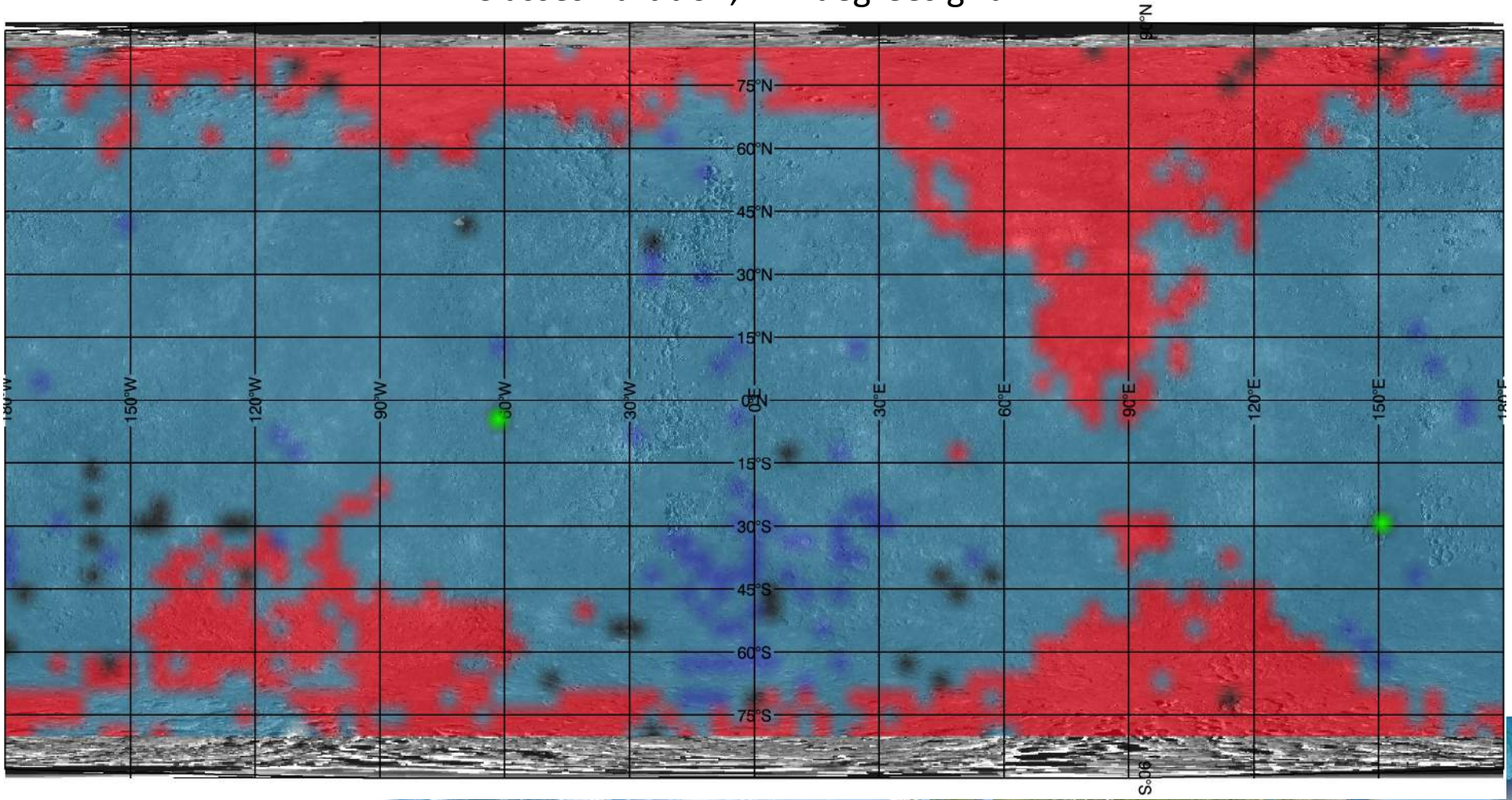
Reflectance(495-505 nm)/Reflectance(700-750 nm) **1x1** degrees grid



Data regridding

Our global classification clustering reveals the existence of two large and spectrally distinct regions, which we call the polar spectral unit (PSU, blue) and the equatorial spectral unit (ESU, red). Further analysis indicates the presence of smaller sub-units that lie near the boundaries of these large regions and may be transitional areas of intermediate spectral character.

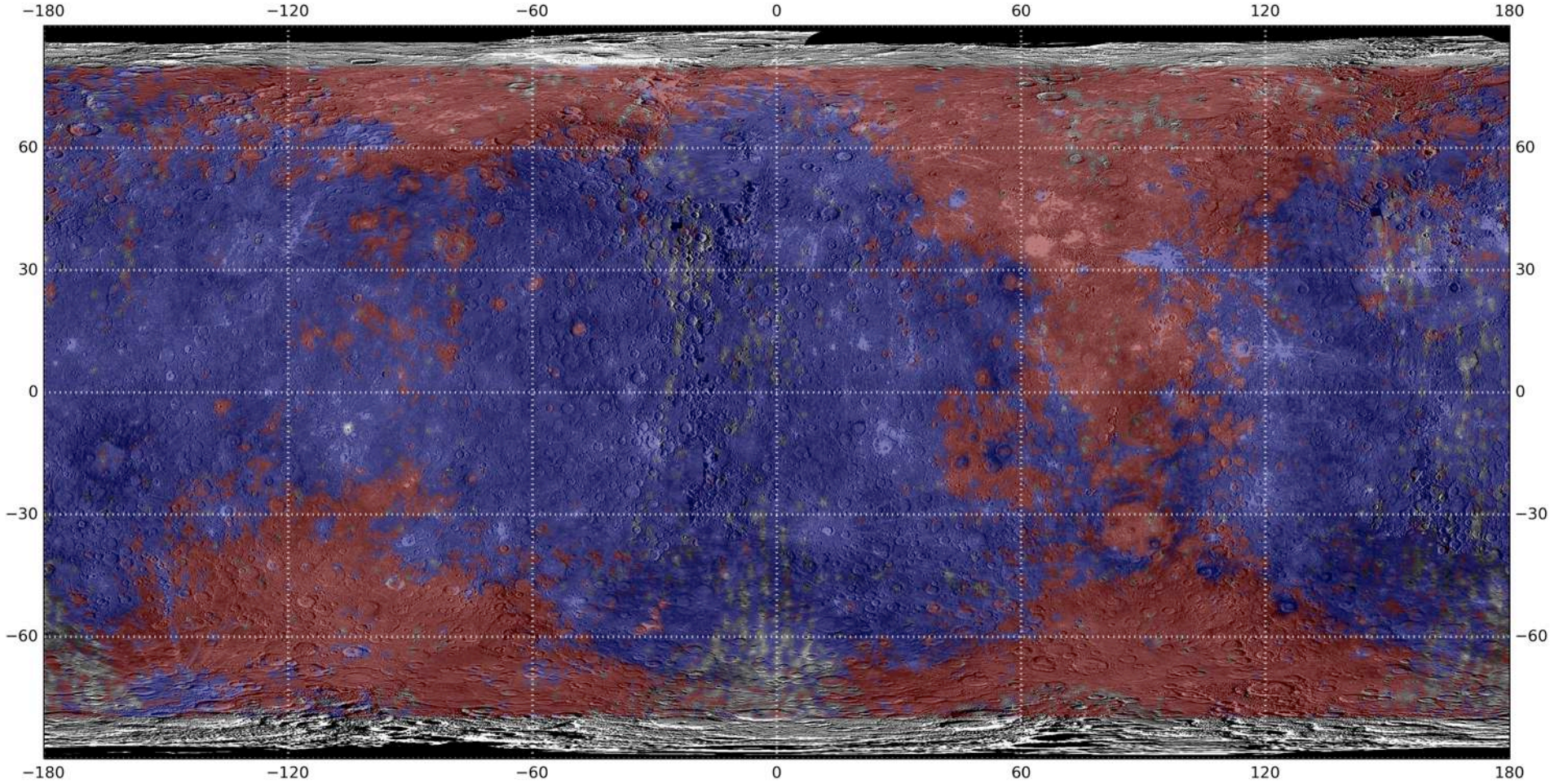
2 Classes Partition, **4x4** degrees grid

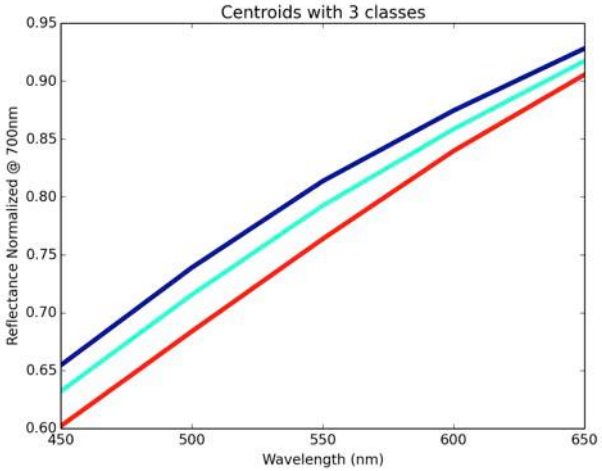


MASCS Data Analysis

Our global classification clustering reveals the existence of two large and spectrally distinct regions, which we call the polar spectral unit (PSU, blue) and the equatorial spectral unit (ESU, red). Further analysis indicates the presence of smaller sub-units that lie near the boundaries of these large regions and may be transitional areas of intermediate spectral character.

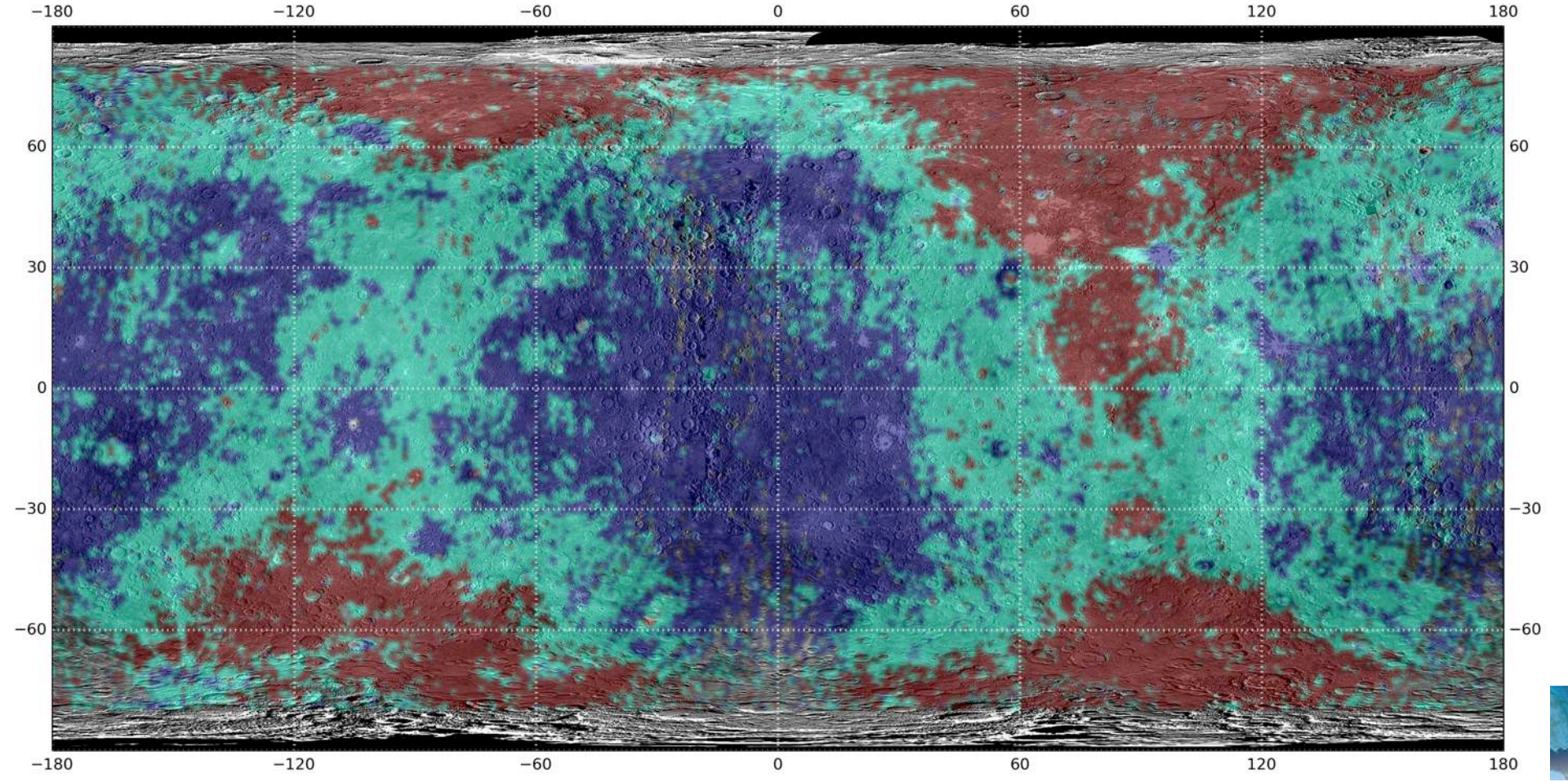
2 Classes Partition**, 1x1** degrees grid



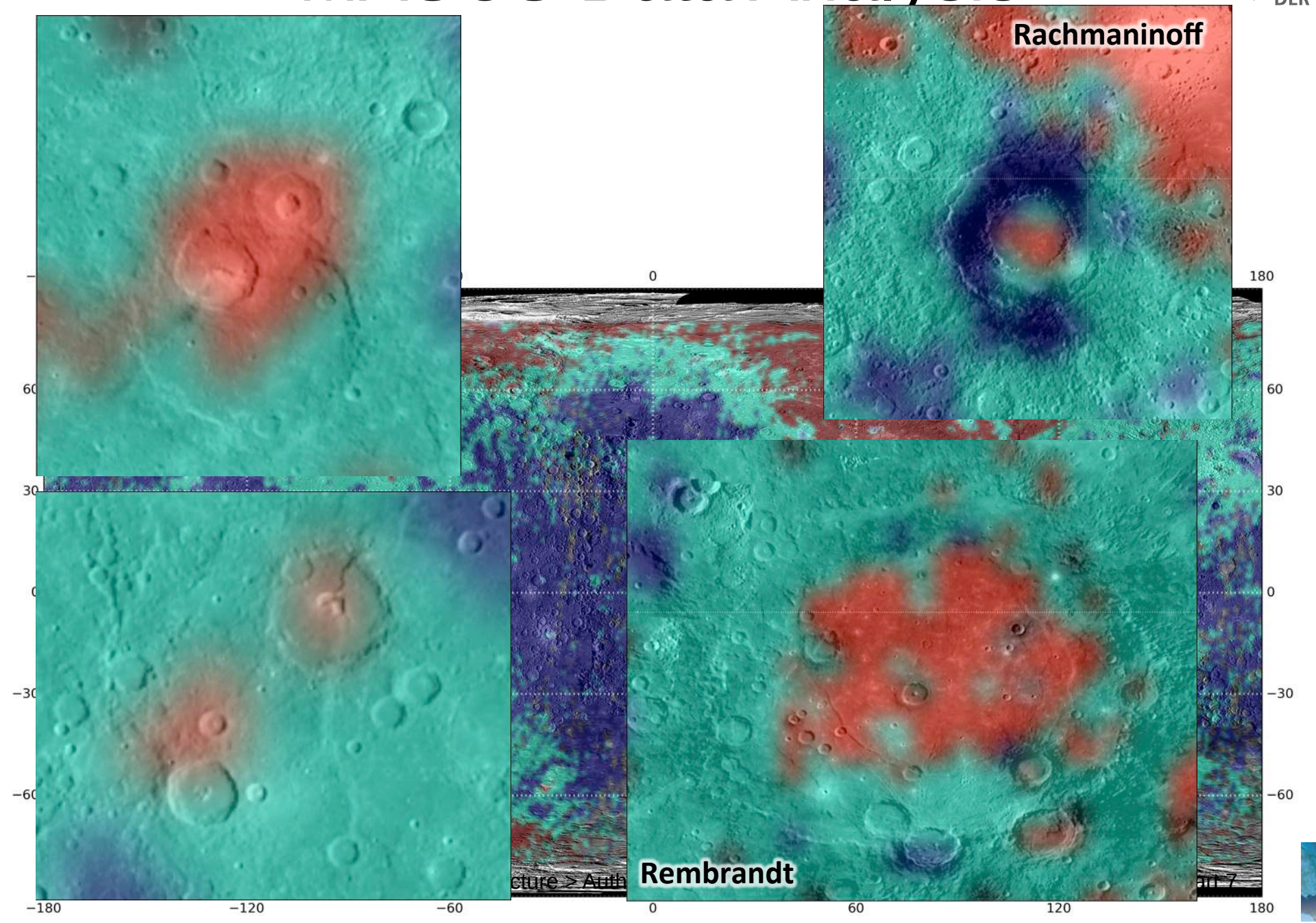


Sampled wavelengths, colors refer to spectral slope

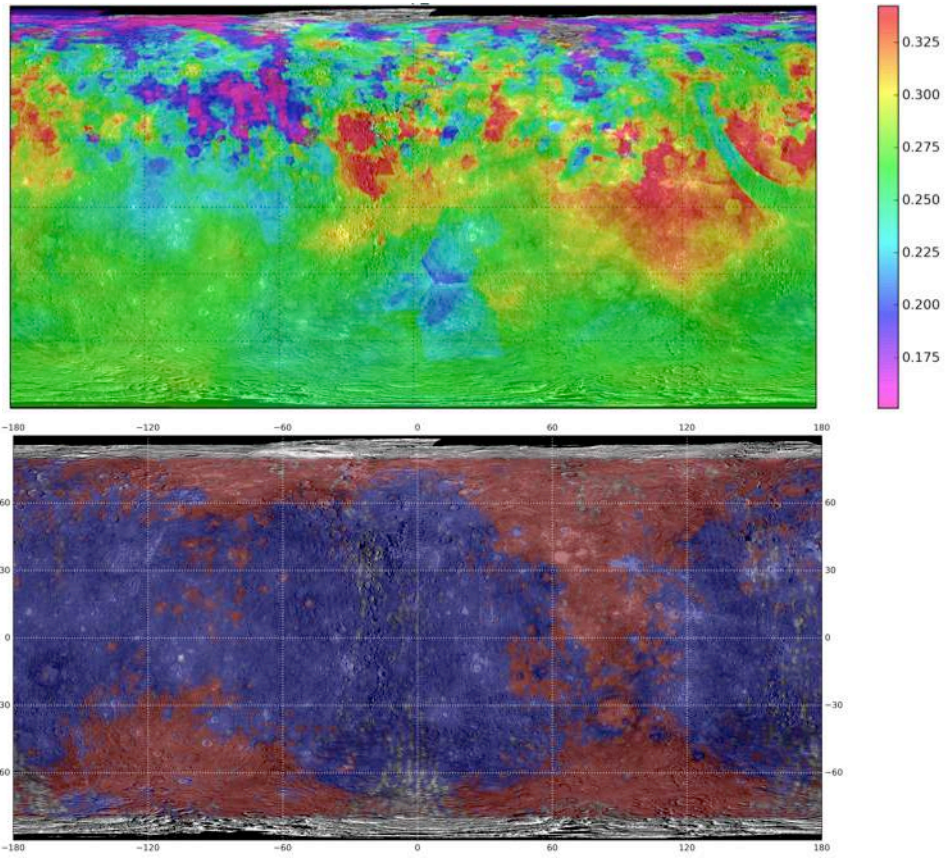
3 Classes Partition, 4x4 degrees grid



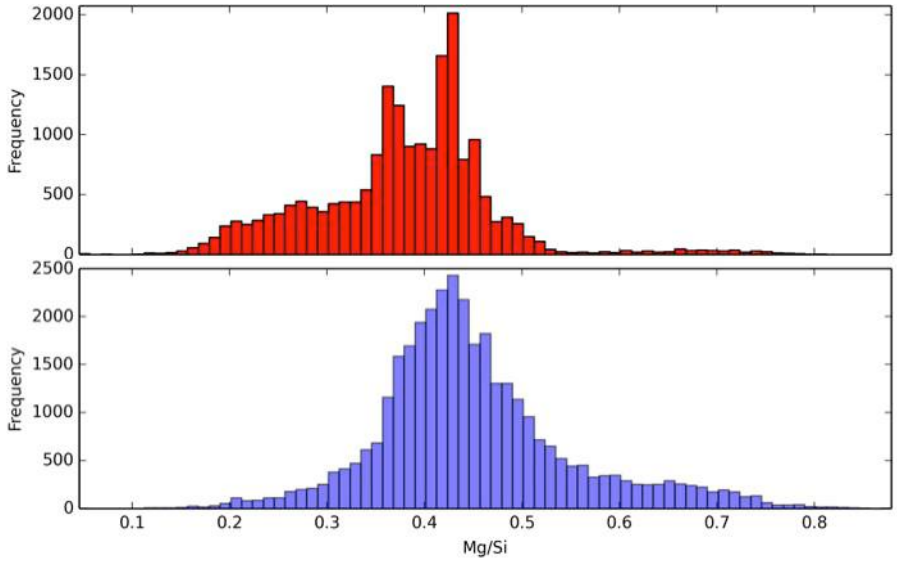
MASCS Data Analysis



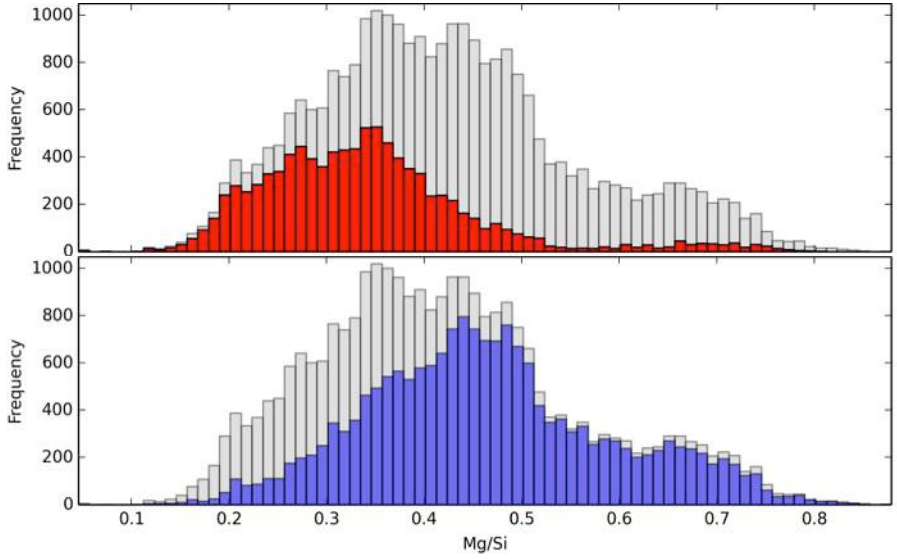
Elemental Maps from XRS



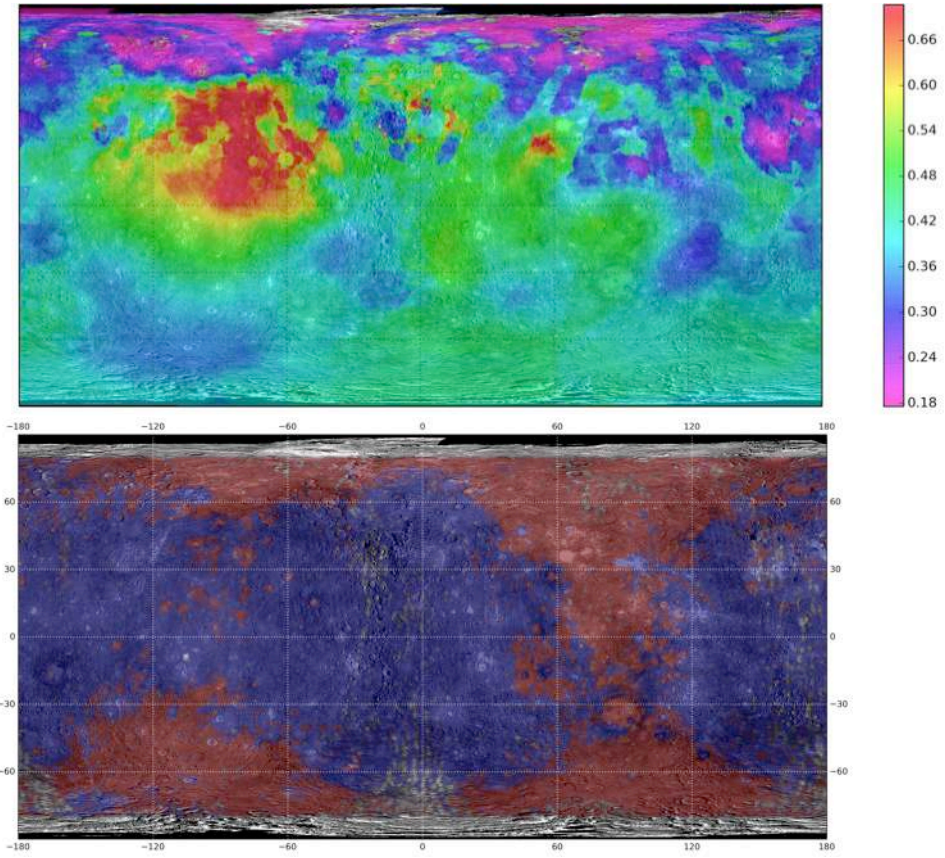
Global distribution



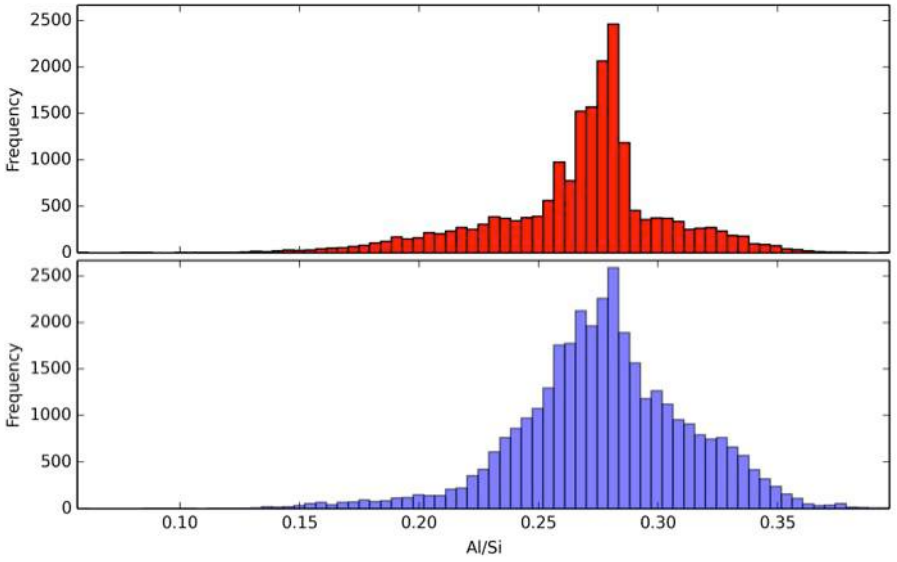
Only North (smaller XRS FOV)



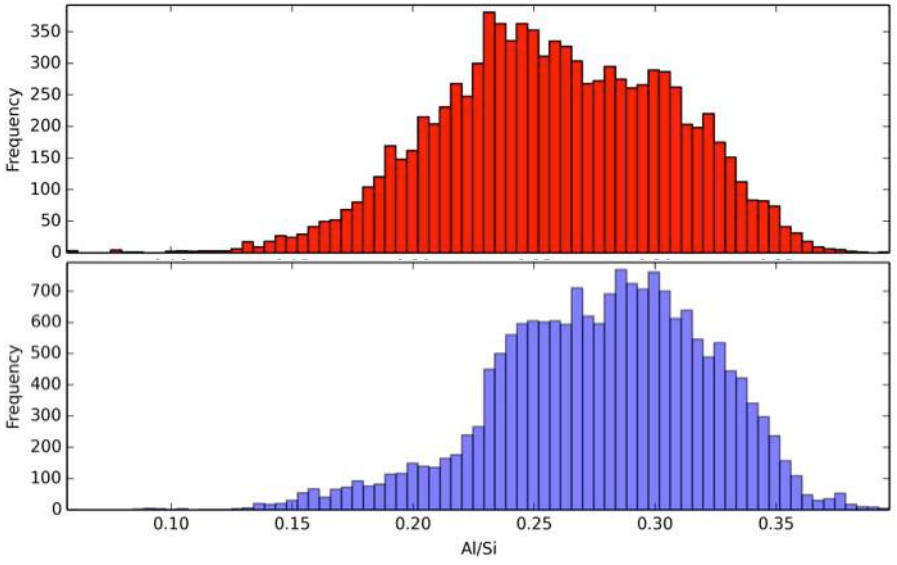
Elemental Maps from XRS

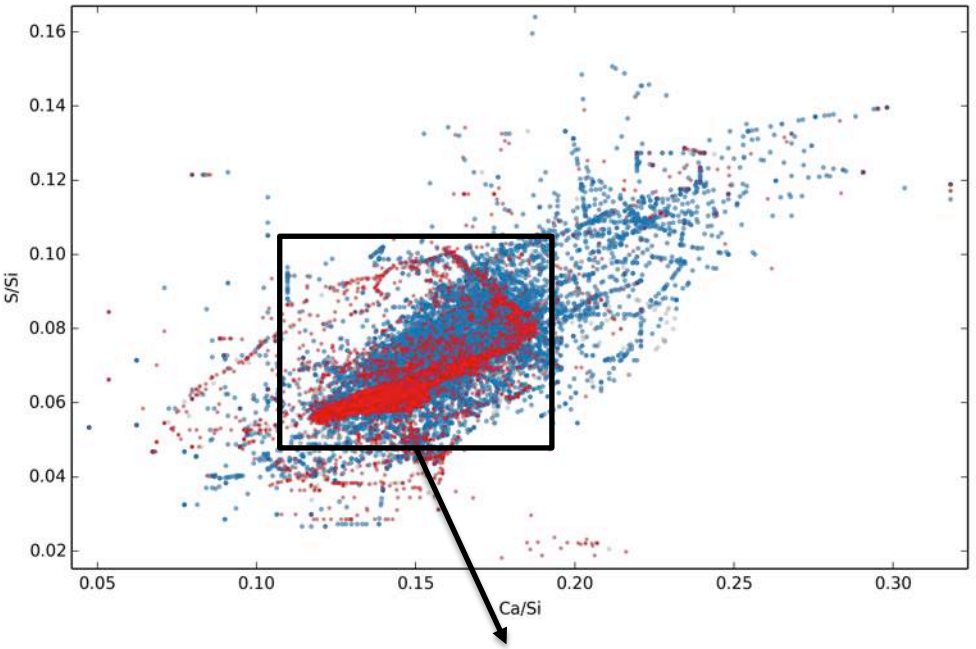


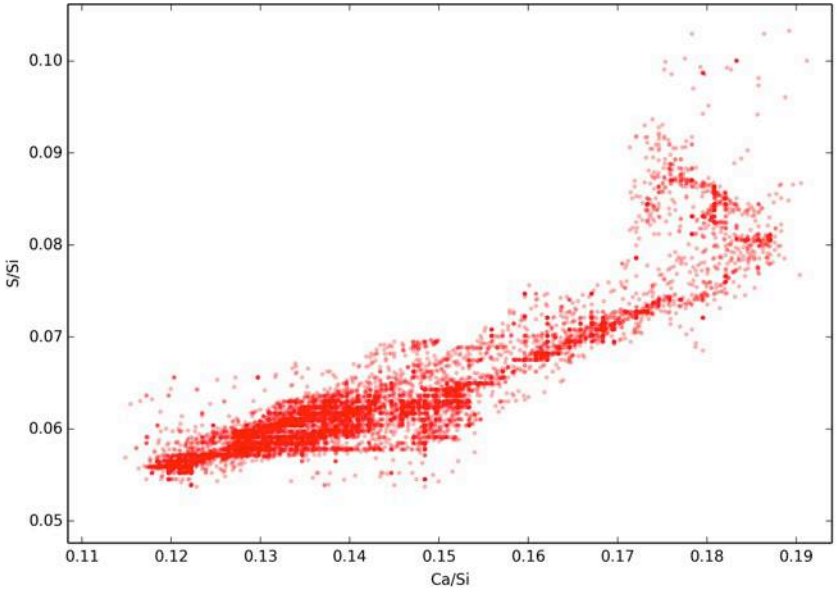
Global distribution

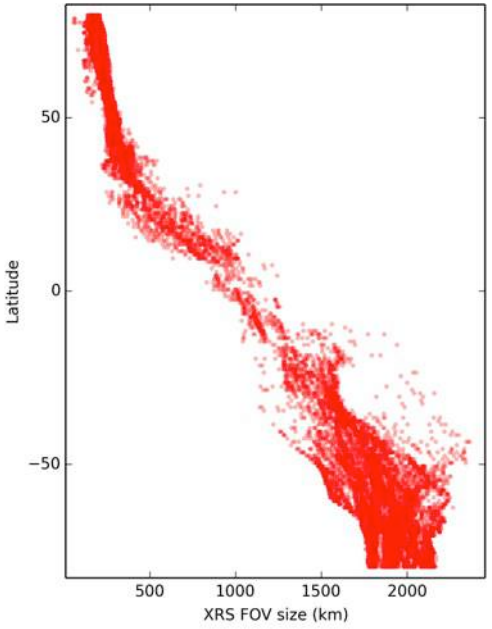


Only North (smaller XRS FOV)

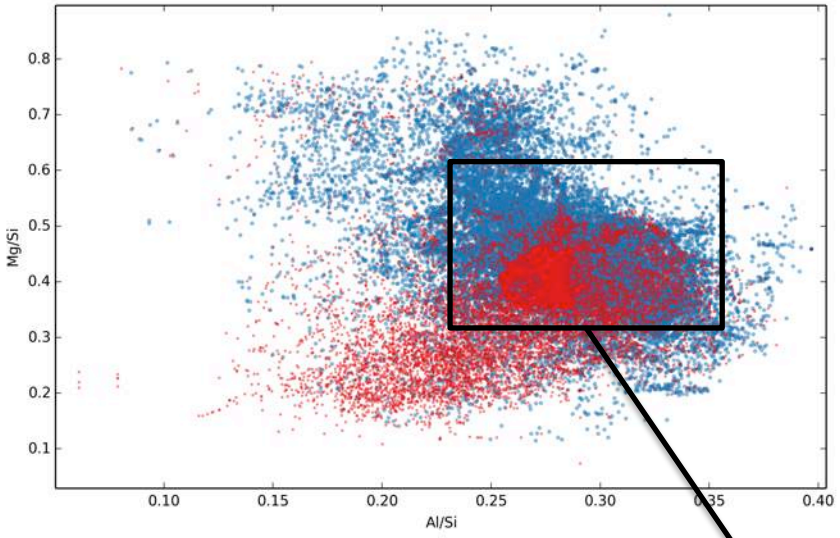



S/Si
Ca/Si
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.05
0.10
0.15
0.20
0.25
0.30

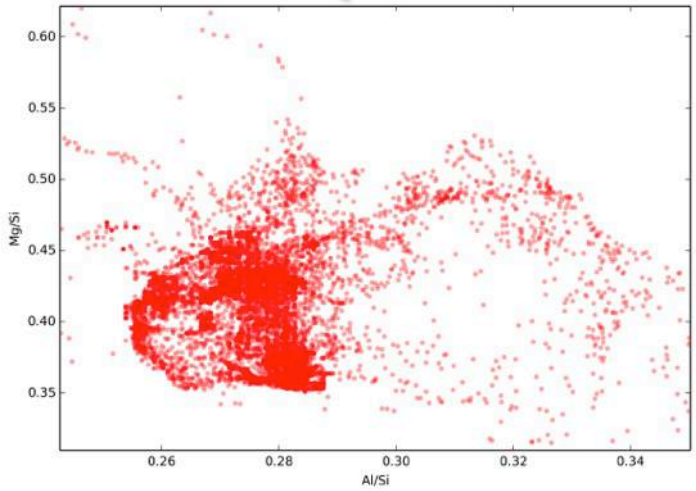

S/Si
Ca/Si
0.10
0.09
0.08
0.07
0.06
0.05
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19

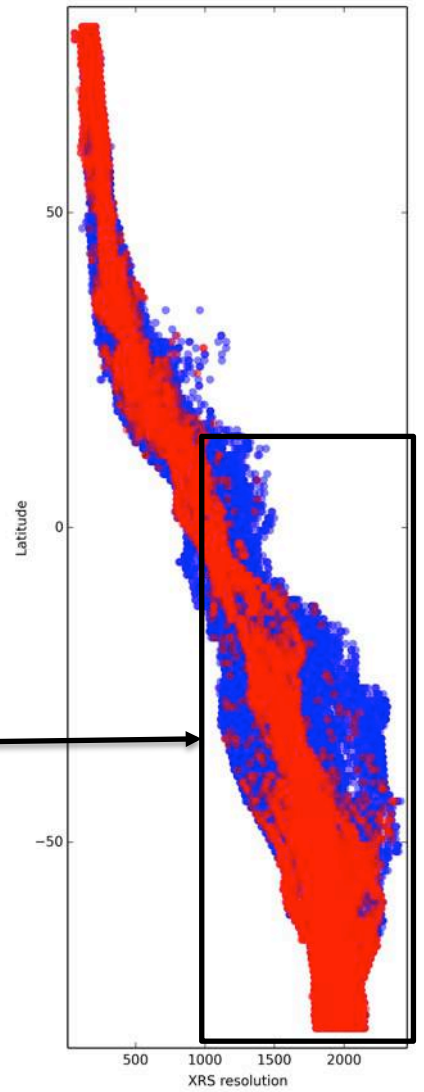

Latitude
XRS FOV size (km)
50
0
−50
500
1000
1500
2000

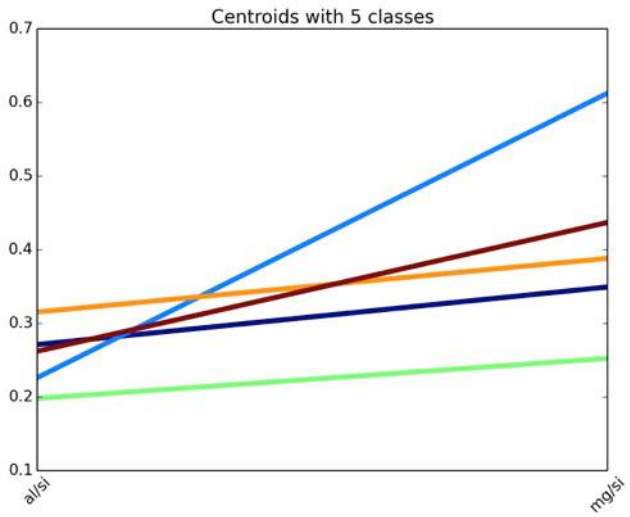
Elemental Maps from XRS

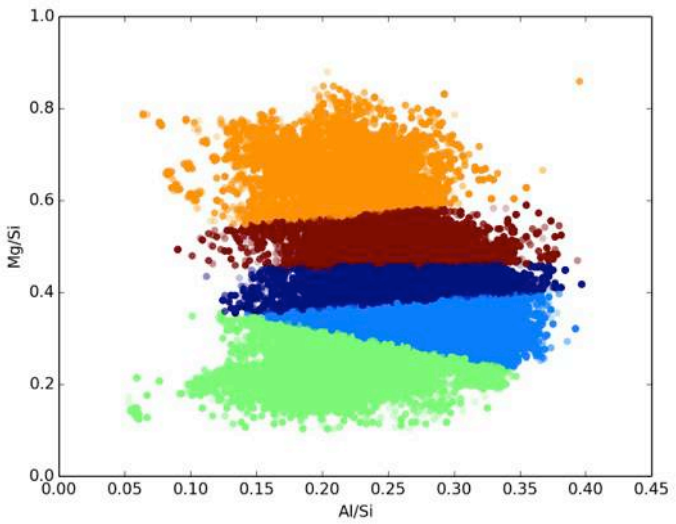


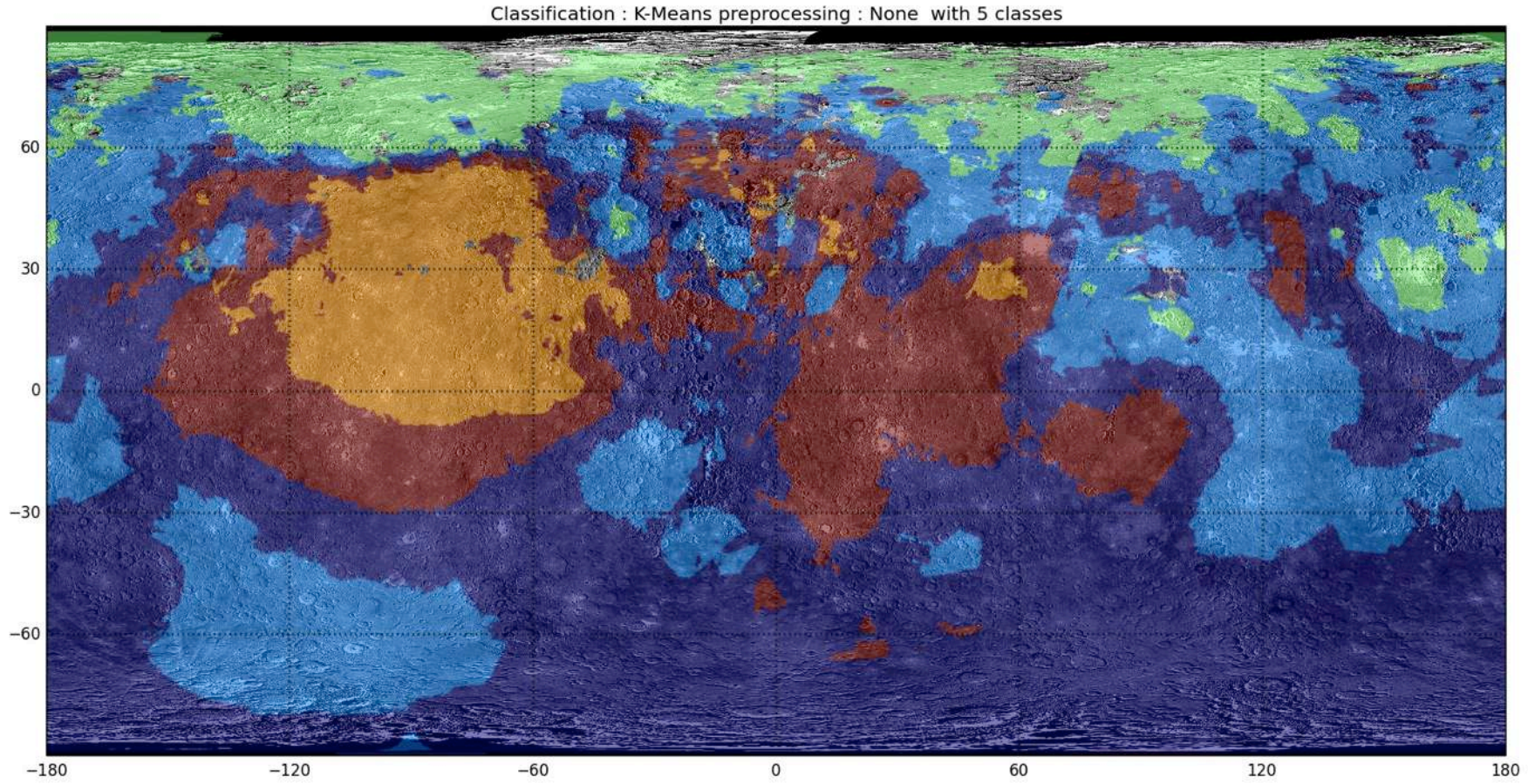
Maximum Density correspond to the south hemisphere PSU spectral region / lowest resolution for XRS (>1000km)

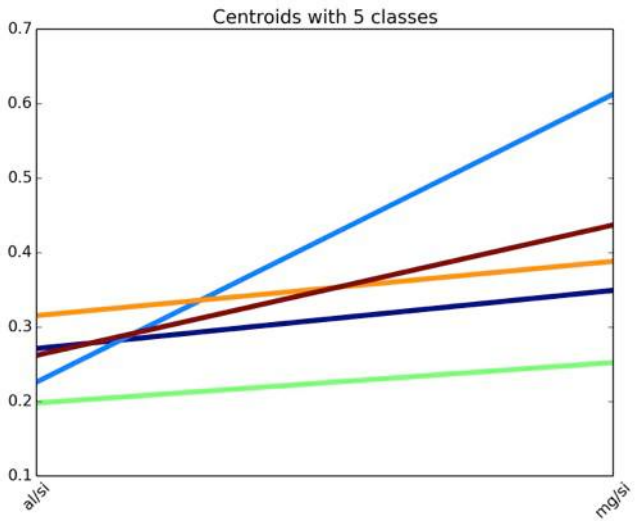


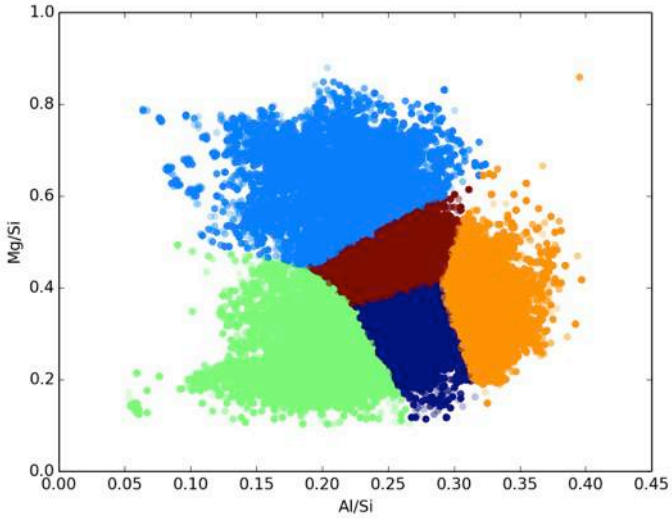


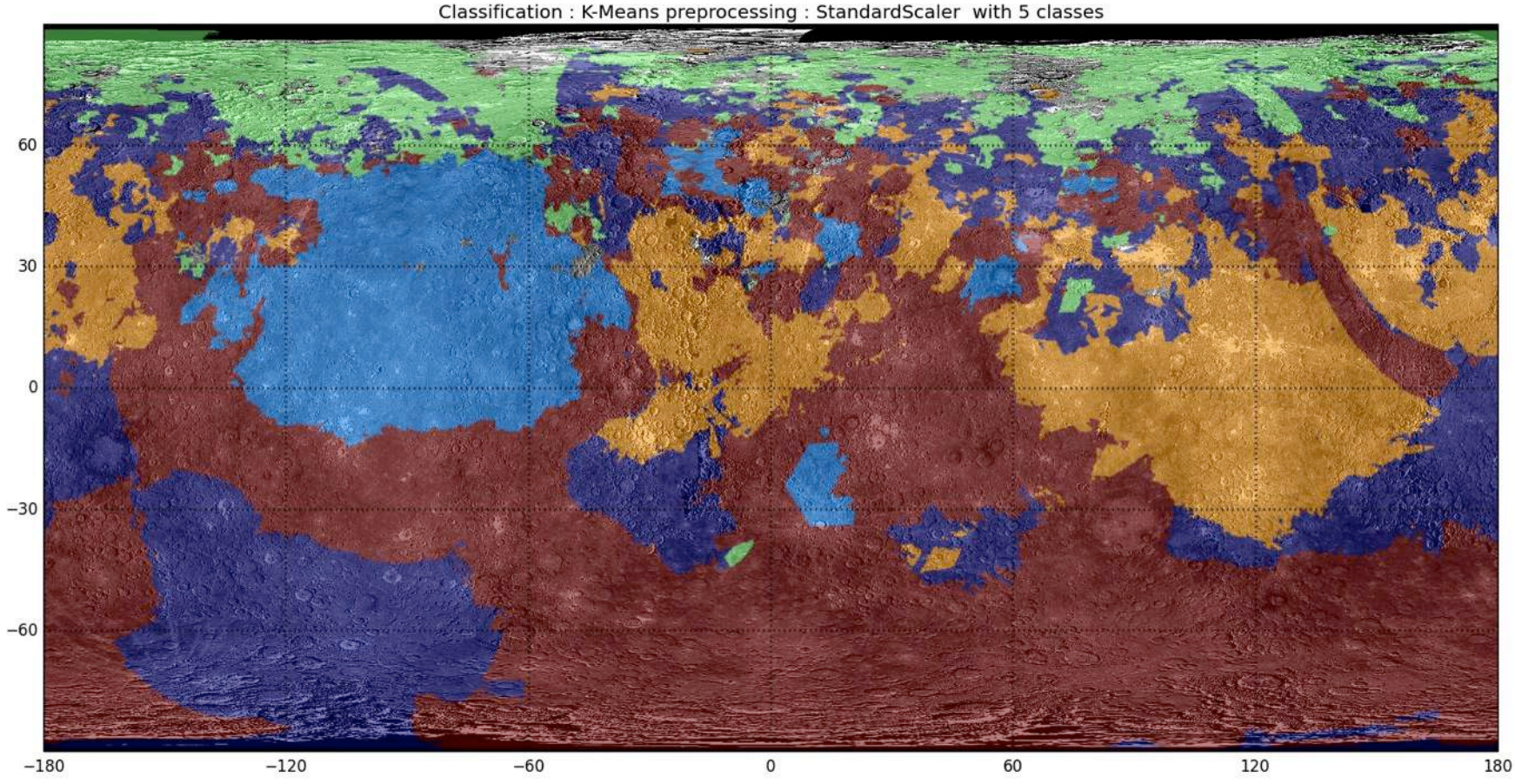

Centroids with 5 classes
0.7
0.6
0.5
0.4
0.3
0.2
0.1
al/si
mg/si


1.0
0.8
0.6
0.4
0.2
0.0
Mg/Si
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
Al/Si


Classification : K-Means preprocessing : None with 5 classes
60
30
0
−30
−60
−180
−120
−60
0
60
120
180

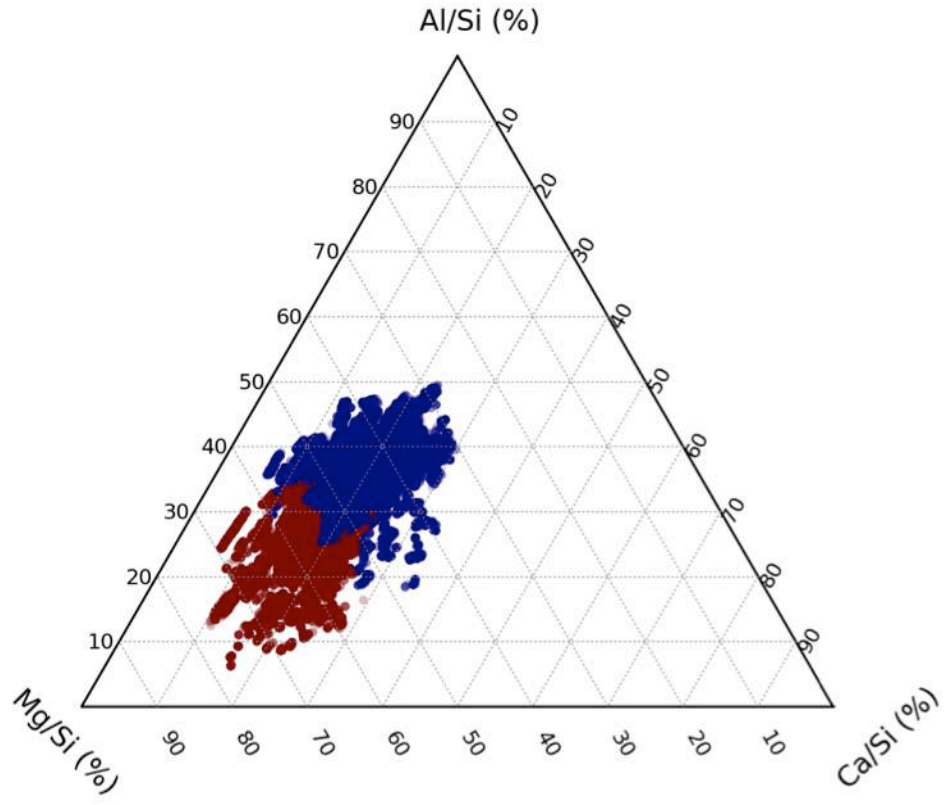

Centroids with 5 classes
0.7
0.6
0.5
0.4
0.3
0.2
0.1
al/si
mg/si


1.0
0.8
0.6
0.4
0.2
0.0
Mg/Si
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
Al/Si

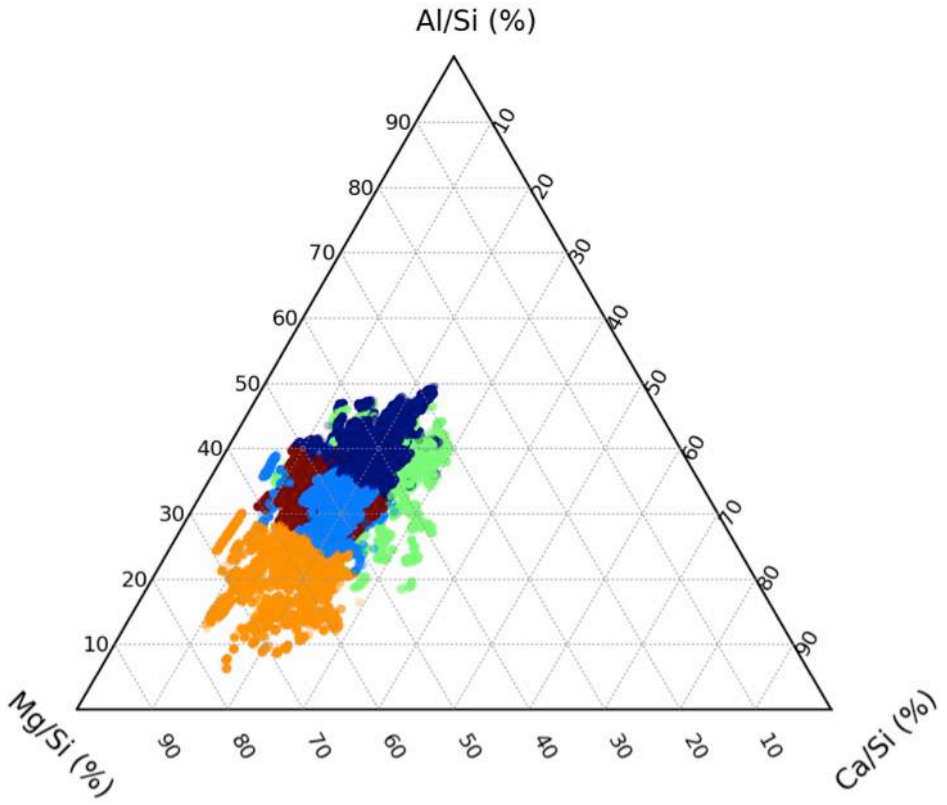

Classification : K-Means preprocessing : StandardScaler with 5 classes
60
30
0
−30
−60
−180
−120
−60
0
60
120
180

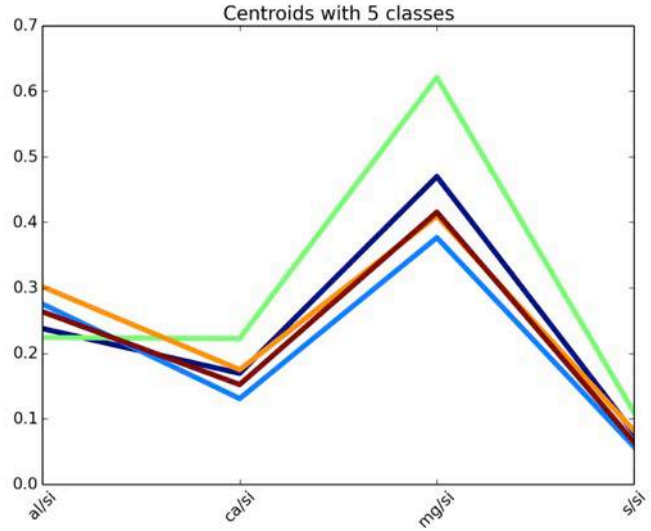
682508 data points

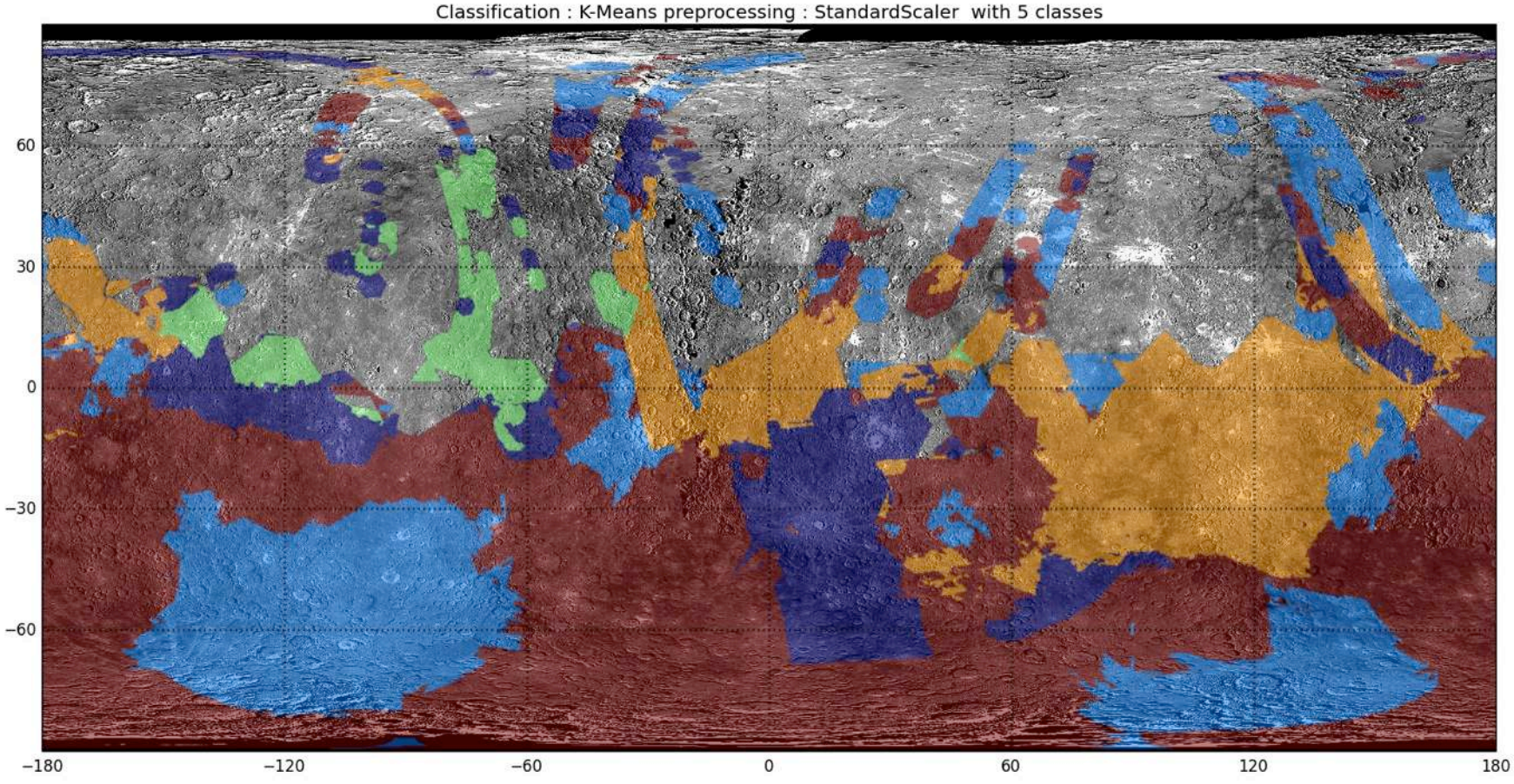
2 classes partition



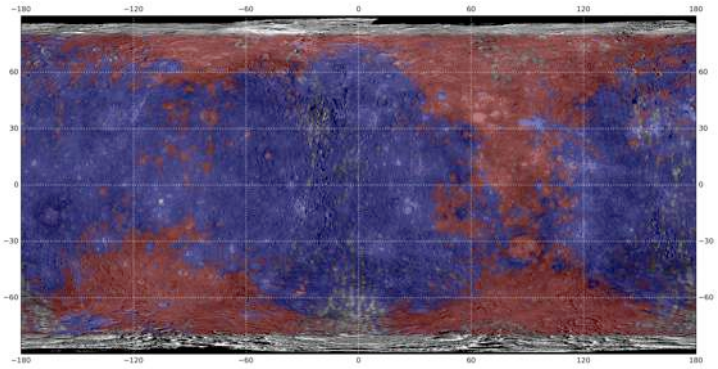
5 classes partition



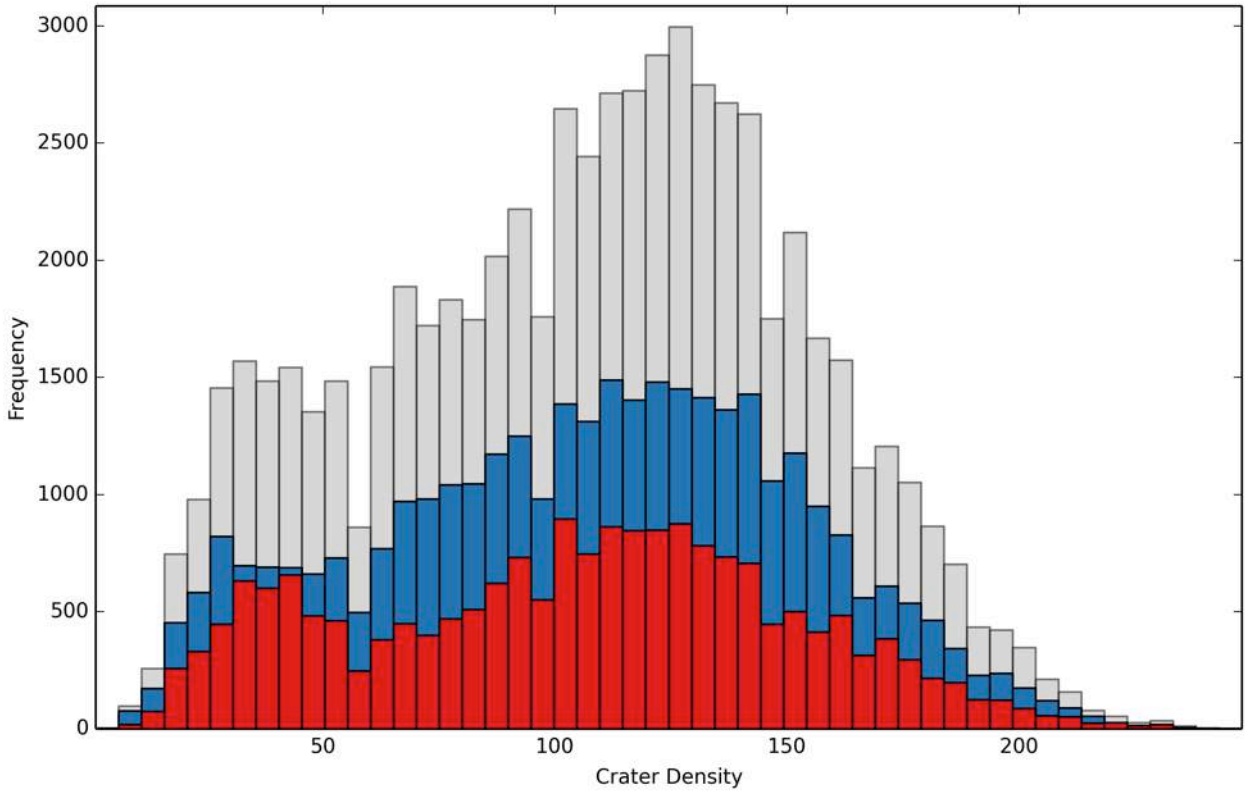

Centroids with 5 classes
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
al/si
ca/si
mg/si
s/si


Classification : K-Means preprocessing : StandardScaler with 5 classes
60
30
0
−30
−60
−180
−120
−60
0
60
120
180

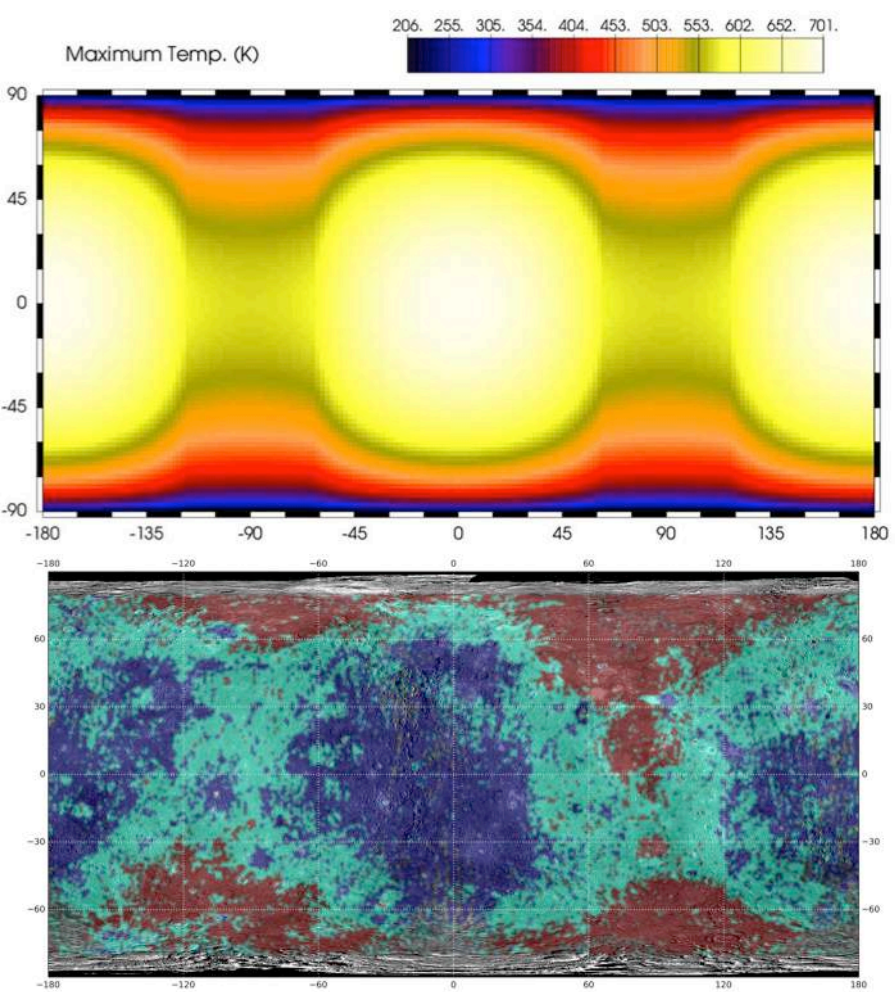
Crater Density

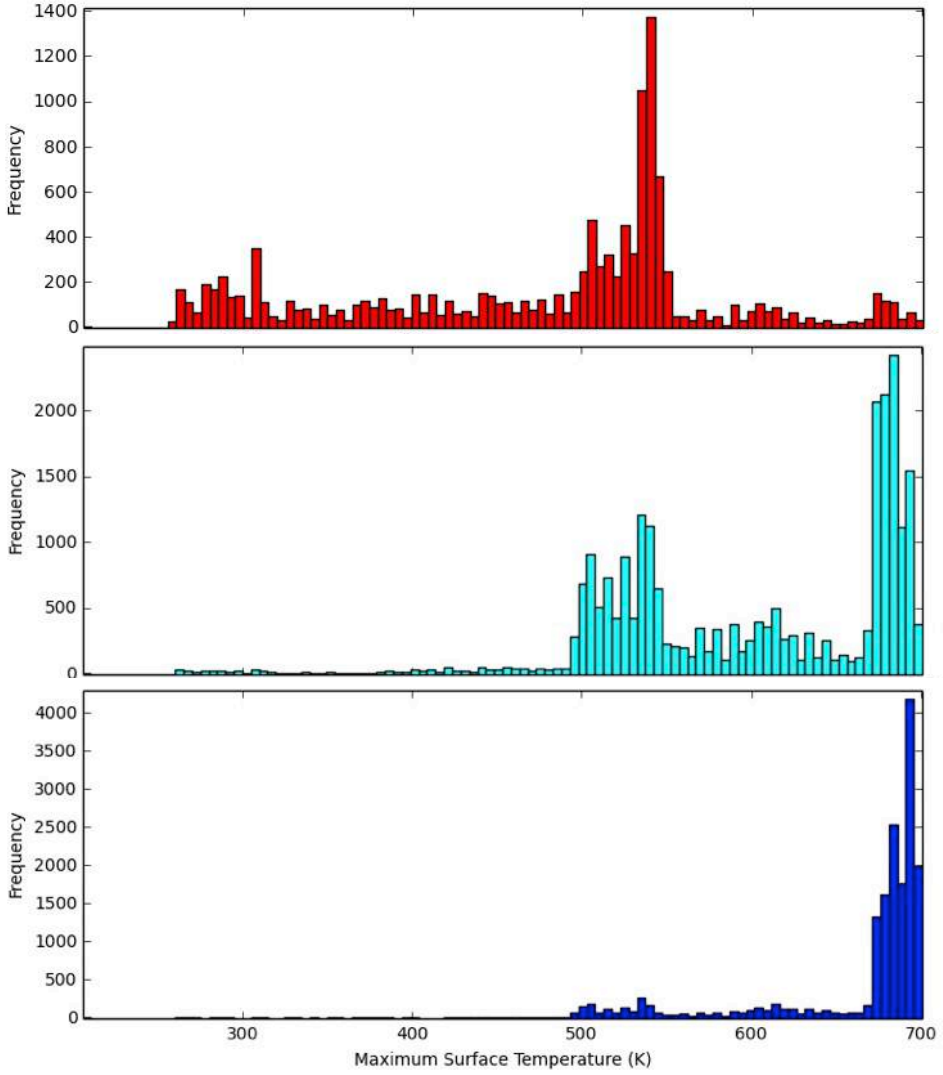


Thanks to Simone Marchi for the Crater Density data

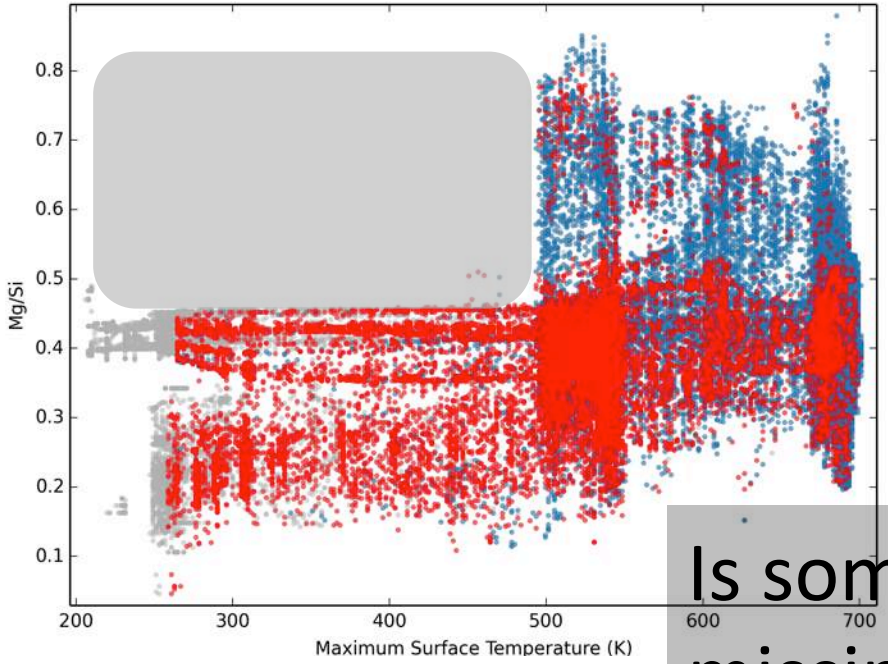


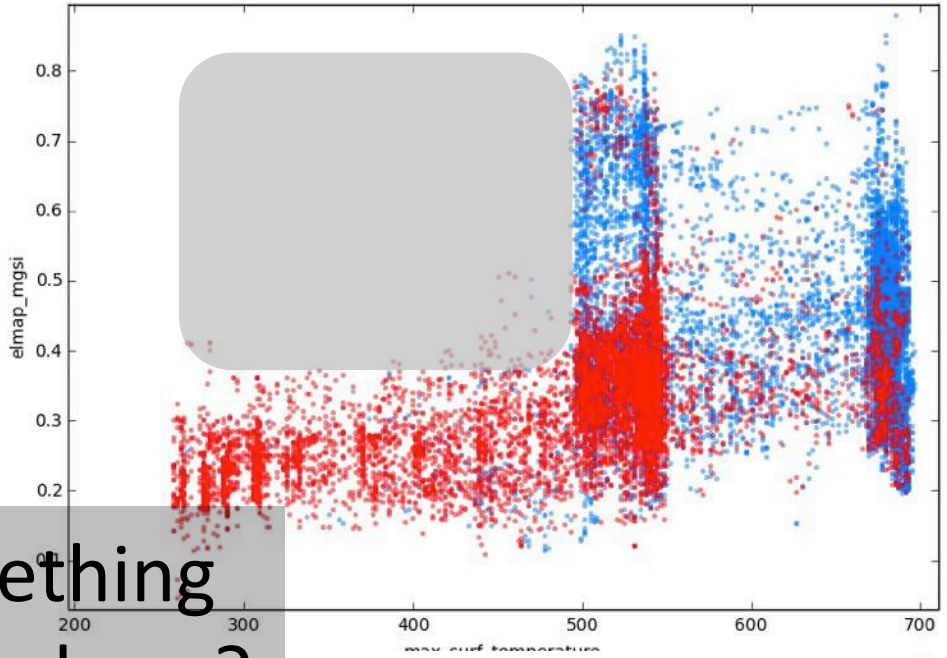
Maximum Temperature



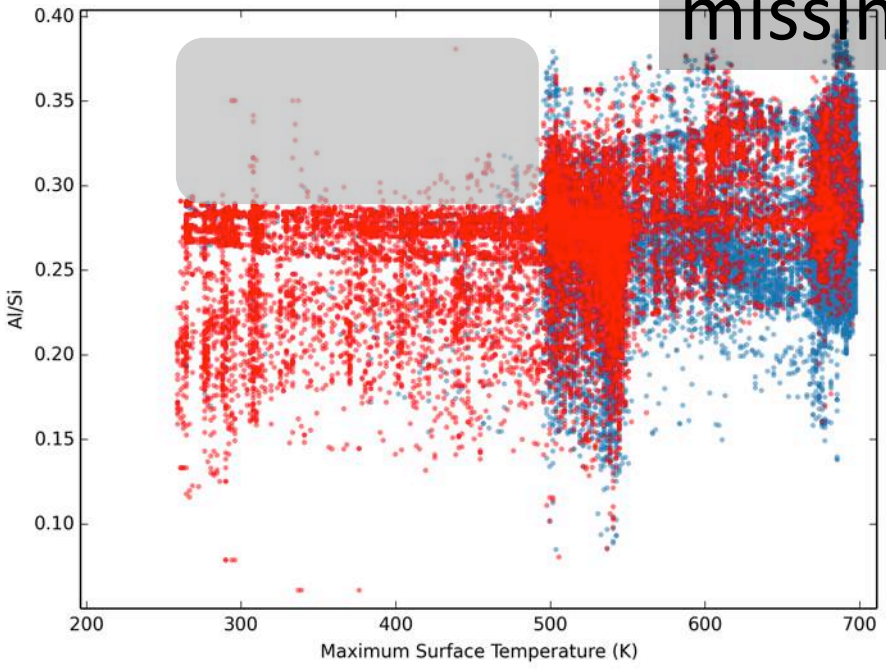


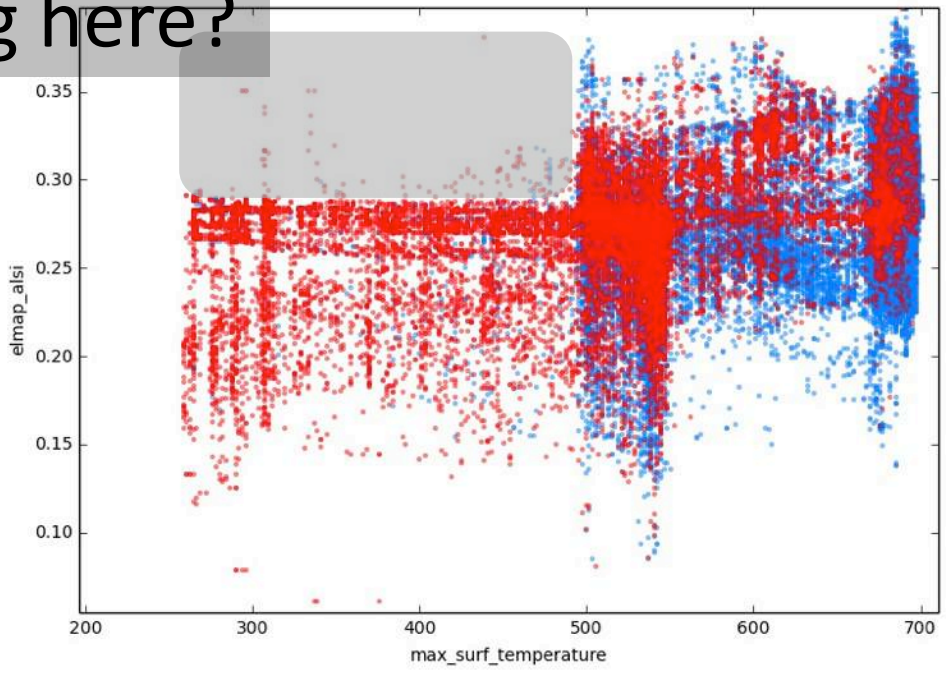
Elemental Ratios vs Max. Temperature



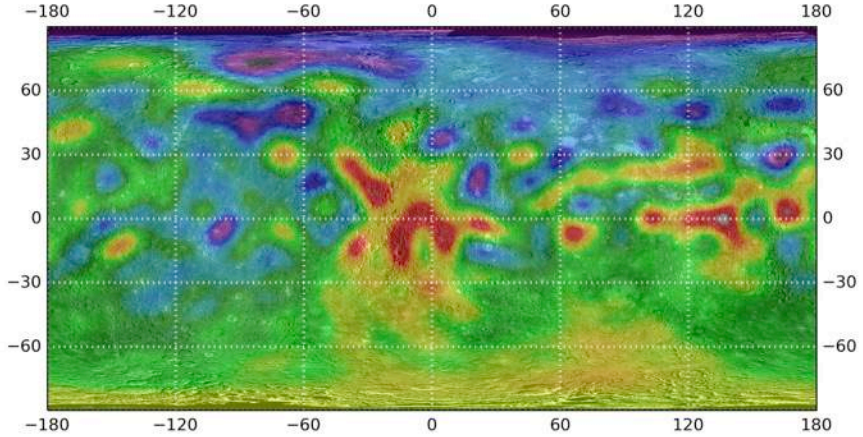


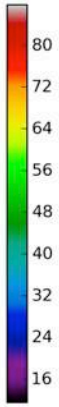
Is something missing here?

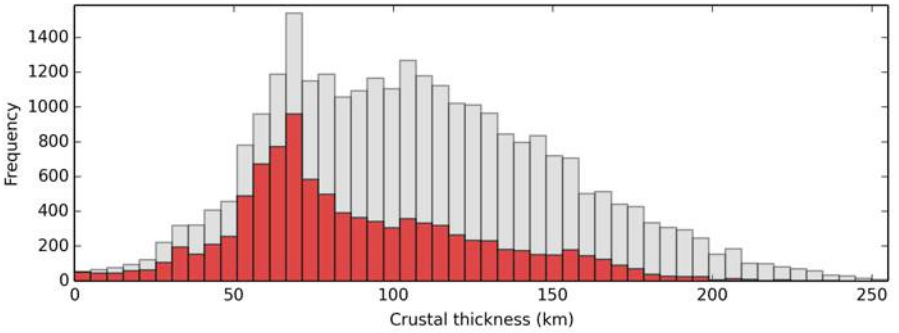


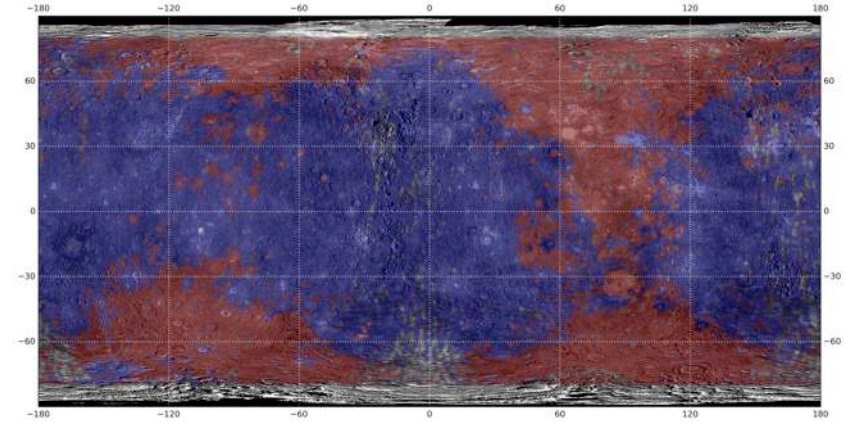


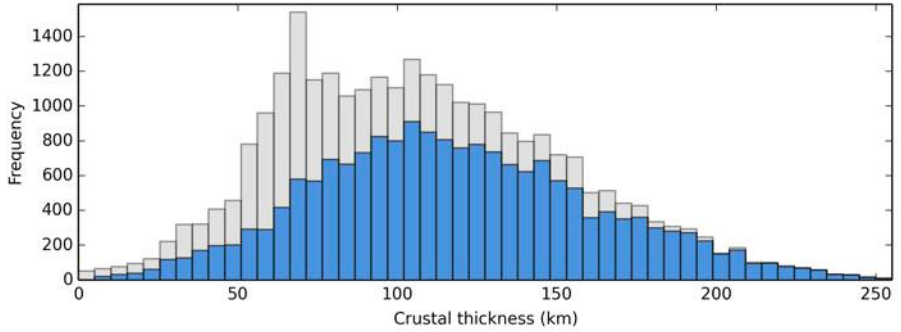
Crustal Thickness











References/Acknowledgment

[1] Helbert J. et al. (2013) *J. Geophys. Res. Planets*, submitted. [2] Head, J. W. et al. (2011) *Science, 333*, 1853–1856. [3] Nittler L. R. et al. (2011) *Science, 333*, 1847–1850. [4] Weider S. Z. et al. (2012) *J. Geophys. Res., 117*, E00L05. [5] Blewett D. T. et al. (2011) *Science, 333*, 1856–1859. [6] Nittler L. R. et al. (2013), *LPS XLIV*, Abstract #2458.

Thanks to the Scikit-learn community for the Machine Learning tools. "Scikit-learn: Machine Learning in Python", Pedregosa et al., JMLR 12, pp. 2825-2830, 2011. http://scikit-learn.org/
Thanks to Christopher Beaumont for his Glue data exploration tool and his personal support. "Multidimensional Data Exploration with Glue", Beaumont et al., Proceedings of the 12th Python in Science Conference, pp. 8 - 12, 2013. http://www.glueviz.org/
Thanks to all co-author for their support, to Simone Marchi for the Crater Density data and the whole MESSENGER Team.